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Additional note on the fresh and brackish water Bryozoa of Israel (Phylactolaemata, Gymnolaemata)

by

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Abstract: Information on the distribution of the hitherto known Israeli freshwater Bryozoa is given. Two species are newly recorded: *Plumatella reticulata* Wood, 1988 and *Lophopodella carteri* (Hyatt, 1866). The occurrence of the brackish water Bryozoan *Victorella pavida* Saville Kent, 1870 is analysed.

Key words: Bryozoa, Phylactolaemata, Gymnolaemata, Israel, freshwater fauna, brackish water fauna, zoogeography, first records.

Introduction

Historically, evidence on Israeli freshwater Bryozoa was given by Barrois (1894), Annandale (1913) and Hastings (1938). Except for two casual records of freshwater species by d'Hondt (1988), the only recent paper on this topic is due to Massard & Geimer (1991).

Materials and Methods

The materials, a kind of by-product of various faunistical researches not specifically Bryozoan oriented, were collected in 12 different sites in Israel. Details on the sites and the collectors are given by the list of the collecting sites and the species found. The determination of the material is due to Jos. A. Massard and Gaby Geimer. The SEM analysis of the statoblasts was made with the Jeol JXA-840 scanning electron microscope of Du Pont de Nemours (Luxembourg) S.A. Concerning the Phylactolaemata the determination of the material essentially was based on Wiebach (1960), Lacourt (1968), Geimer & Massard (1986, 1987), Wood (1988, 1989); concerning the Gymnolaemata Braem (1951), Prenant & Bobin (1956) and Hayward (1985) were used.

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List of the collection sites and the samples including the species found

1. Bab el Hawa

   1a. Bab el Hawa Pool (near the road), 26.8.1989, leg. Bromley. Species: *Plumatella repens* (Linné, 1758).

   1b. Birket Bab el Hawa (pool 2) (HUJ-G21), 10.7.1967, leg. HUJ expedition, floatoblasts. Species: *Plumatella* sp., *Lophopodella capensis* (Sollas, 1908).

2. Hula Nature Reserve

   2a. Hula Nature Reserve, from *Nuphar* leaves, 15.8.1989, leg. Dimentman. Species: *Plumatella casmiana* Oka, 1907.

   2b. Hula Nature Reserve (HUJ-U8), 12.3.1964, leg. HUJ expedition. Species: *Lophopus crystallinus* (Pallas, 1768).

   2c. Hula Nature Reserve (HUJ-Z.8), 12.3.1964, leg. HUJ expedition, floatoblasts only. Species: *Plumatella repens* (Linné, 1758), *Plumatella fungosa* (Pallas, 1768), *Hyalinella punctata* (Hancock, 1850), *Lophopus crystallinus* (Pallas, 1768).

   2d. Hula Nature Reserve (HUJ-D12), 10.3.1966, leg. HUJ expedition. Species: *Lophopus crystallinus* (Pallas, 1768).

   2e. Hula Nature Reserve (st. 2), 7.5.1989, leg. Dimentman, floatoblasts. Species: *Lophopodella carteri* (Hyatt, 1866), *Lophopus crystallinus* (Pallas, 1768), *Plumatella casmiana* Oka, 1907, *Plumatella emarginata* Allman, 1844.

   2f. Hula Nature Reserve (st. 10), puddle, 7.5.1989, leg. Dimentman, floatoblasts. Species: *Plumatella repens* (Linné, 1758).

3. "Nahal Aqeb" (st. 1), Bet Zaida Valley, 11.3.1985, leg. Dimentman & Werechson. Species: *Plumatella fungosa* (Pallas, 1768), *Plumatella emarginata* Allman, 1844.

4. Kefar Barukh Reservoir

   4a. Kefar Barukh Reservoir, Sample A, 30.8.1990, leg. G. Sagi & Ch. Dimentman. Species: *Plumatella reticulata* Wood, 1988.

   4b. Kefar Barukh Reservoir (dry material), Sample B, 30.8.1990, leg. G. Sagi & Ch. Dimentman. Species: *Plumatella reticulata* Wood, 1988.

5. Nahal Alexander (near mouth), 2.6.1964, leg. HUJ expedition. Species: *Lophopodella capensis* (Sollas, 1908), *Victorella pavida* Saville Kent, 1870.

Ecological notes on habitat sites

1. Birket Bab el Hawa

This is a semi-permanent pool in the Golan Heights which is fed by rain run-off. According to Ar (1970), the maximal area of the pool is about 12 hectares, and most of it dries out during the summer and autumn. Seasonal fluctuations, reported by Ar (1970), of several environmental parameters are as follows:

water temperature	6.0 - 27.9 °C
dissolved oxygen	6.1 - 13.7 ppm
electrical conductivity	0.119 - 1.5 mS/cm²

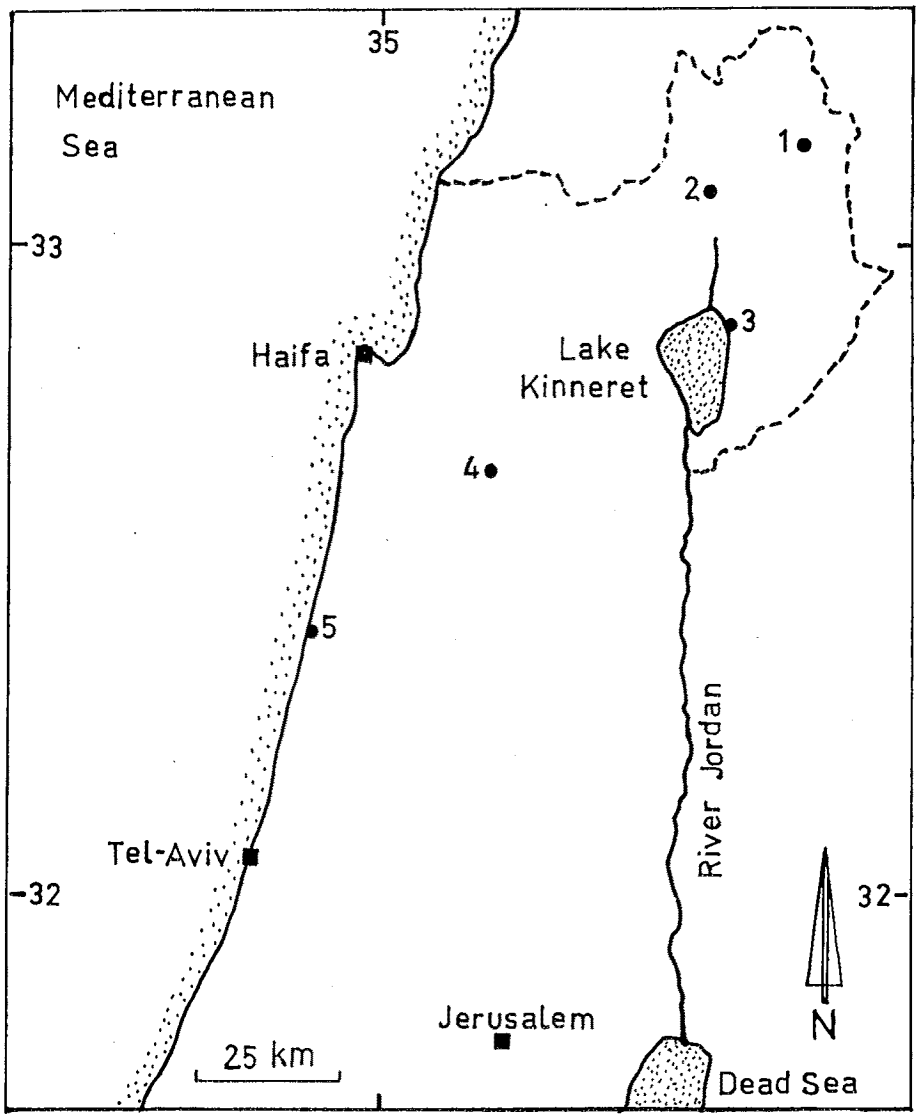


Fig. 1. - Map of the collection sites. 1. Bab el Hawa, 2. Hula Nature Reserve, 3. "Nahal Aqeb", 4. Kefar Barukh Reservoir, 5. Nahal Alexander.

2. Hula Nature Reserve

The Hula Nature Reserve exists only since the drainage of the former freshwater Lake Hula and associated swamps in the late 1950's. The water quality in the Hula Nature Reserve in 1964-66 was relatively good compared with the present time. Some parameters of water quality were measured in December 1965 and June 1966 by Kugler and Wool (1968) as follows:

chlorinity	32.0 - 62.4 mg/l
pH	7.9 - 8.3
water hardness ($CaCO_3$)	240 - 270 mg/l
phosphate (PO_4)	0.02 - 0.04 mg/l
nitrogen (mainly NO_3)	1.35 - 1.85 mg/l
diurnal water temperature:	summer 25° - 30°C
	winter 12° - 18°C

3. "Nahal Aqeb"

This stenothermic stream is one of the small tributaries of Lake Kinneret. The water temperature during winter is higher than of the Lake water (for example on 11.3.85, the stream temperature was 17.5-21°C while in the Lake it was 14-15°C). Other chemical data on 11.3.85 are as follows:

chlorinity	255 mg/l
pH	8
dissolved phosphate	0.166 mg/l
nitrogen (NO_3)	1.7 mg/l

4. Kefar Barukh Reservoir

This artificial reservoir was constructed in the 1950's. During the first years, it was fed solely by winter run-off from the surrounding area. Gradually, an increasing amount of both treated and non-treated sewage was introduced into the reservoir. From time to time, Kefar Barukh reservoir also receives clean water from Lake Kinneret via the National Water Carrier.

The chlorinity and water quality of this reservoir fluctuates over the years. Limnological studies in the collection site of *Plumatella reticulata* during a period of 15 months before the collection date of this species (June 1990 - August 1991) shows that chlorinity ranged from 190 to 504 mg/l, electrical conductivity from 0.9 to 2.6 mS/cm^2 and water temperature ranged from 9° to 28°C (M. Juanico, pers. comm.).

5. Nahal Alexander

Nahal Alexander is one of the permanent coastal streams of Israel. In the 1960s, it was a non-polluted freshwater stream for most of its course, with estuarine and brackish fauna near its mouth. Colonies of *Victorella pavida* were found in the estuary which was also characterized by large colonies of the serpulid *Phycopomatus enigmaticus*, large populations of *Nereis diversicolor*, marine-estuarine benthic copepods like *Canuella perplexa* and the euryhaline rotifer *Brachionus plicatilis* (Sh. Pisanti, pers. comm.; Por, 1989).

According to the observations of Pisanti (in litt.), the annual cycle of *V. pavida* colonies in Nahal Alexander was as follows: During winter, the only organs which were observed on the tubes were the dark hibernaculi. In March, budding of stolons began below the hibernaculi, and in April the first zooids were observed. During May and June, the growth spread into a large cover of stolons and zooids. In August, production of resting bodies began, and this was associated with a gradual decrease in the number of zooids as the stolons degenerated.

During the last two decades, Nahal Alexander has become polluted with a BOD greater than 40, and most of the former aquatic fauna, including *V. pavida*, has disappeared.

Results

Besides one undeterminable *Plumatella* sp. sessoblast detected in the material from site 1b, the following species have been identified:

Plumatella casmiana Oka, 1907

In site 2a six well developed colonies, stuffed with floatoblasts were collected. Many of the numerously present leptoblasts had already germinated. There were no sessoblasts. In site 2e only floatoblasts were collected.

Plumatella repens (Linné, 1758)

Colonies with some floatoblasts were found in site 1a (one fragment) and site 2f (three fragments), only floatoblasts in site 2c .

Plumatella fungosa (Pallas, 1768)

Floatoblasts were collected in site 2c and site 3.

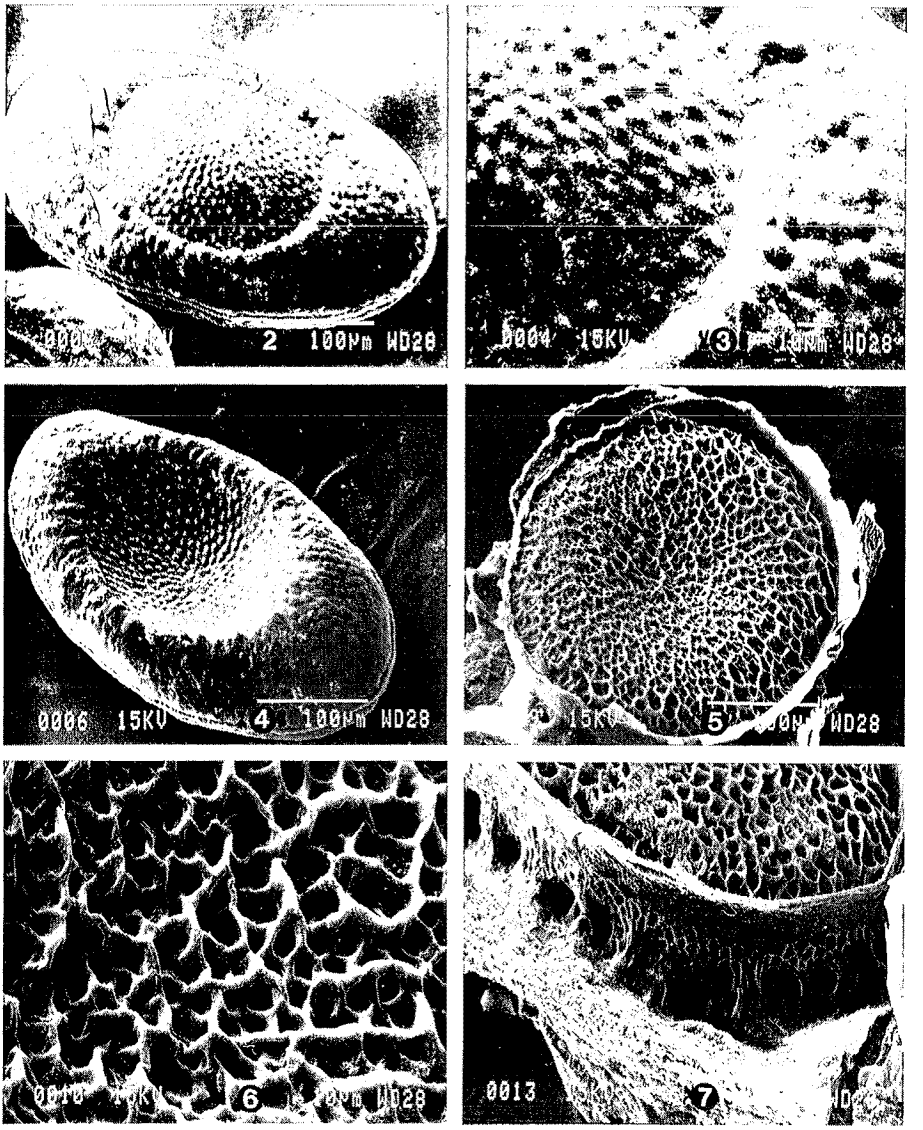
Plumatella emarginata Allman, 1844

Some floatoblasts were present in the material from site 2e and site 3.

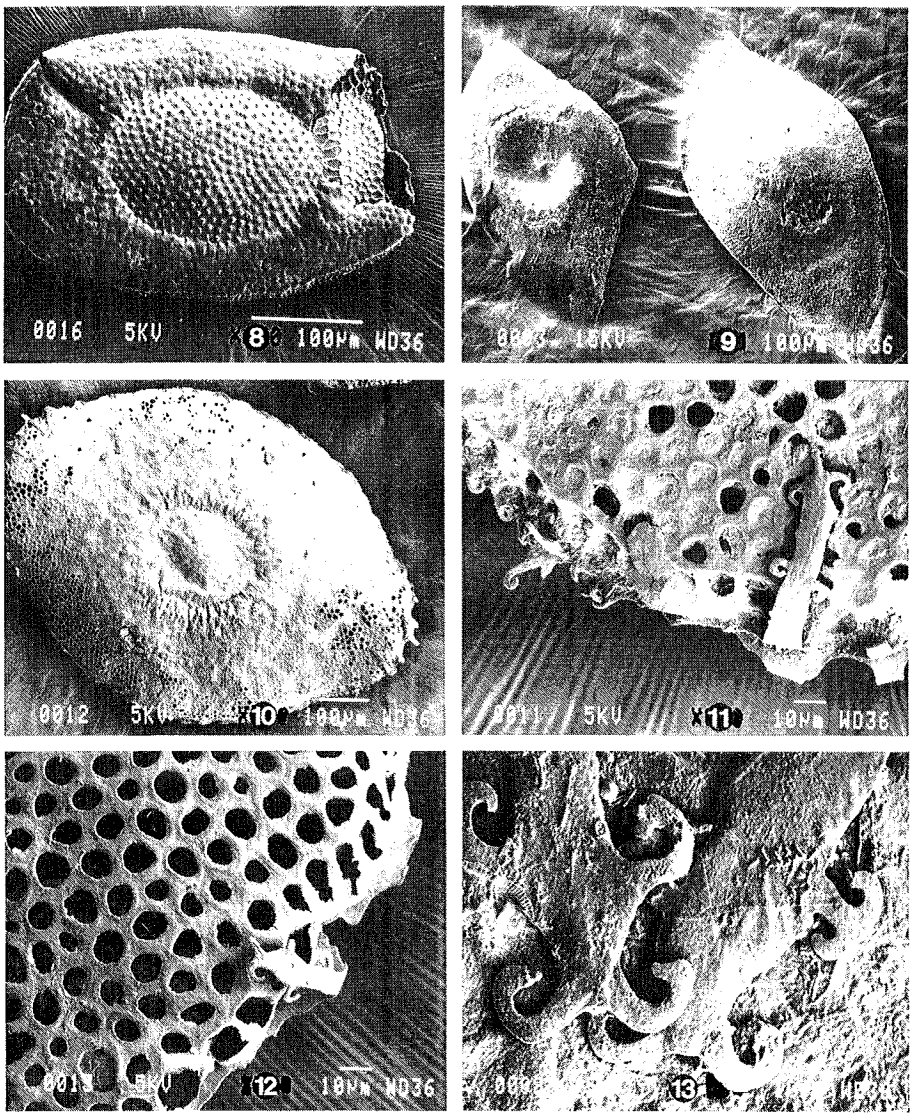
Plumatella reticulata Wood, 1988
(Figs 2-7)

Site 4b yielded compact, cushion-like colonies with erect and laterally agglutinated cystids conferring a honeycomb-like aspect to the elder parts of the colony, whereas elsewhere the zooecial tips were free; the cystids were stuffed with floatoblasts. The colonies found in site 4a were also cushion-like. Typical reticulated sessoblasts were present in both sites.

Most of the floatoblasts are «broadly oval with long sides nearly straight and parallel» and so quite fitting to the description of Wood (1988, 1989). Typically the dorsal fenestra (free part of the annulus) is very narrow; ventrally it is somewhat larger.



Figs 2-7. - *Plumatella reticulata*, site 4b. Fig. 2: Fb dorsally, capsule with tuberculation, scale bar = 100 µm. Fig. 3: Fb dorsally, detail of fig. 1, capsule on the left, annulus on the right, scale bar = 10 µm. Fig. 4: Fb ventrally, scale bar = 100 µm. Fig. 5: Sb, frontal side, capsule reticulated, annulus smooth, scale bar = 100 µm. Fig. 6: Sb, detail of fig. 4, scale bar = 10 µm. Fig. 7: Sb, lateral view, reticulation on the wall, scale bar = 100 µm (Fb = floatoblast).



Figs 8-13. Fig. 8: *Hyalinella punctata*, site 2c, Fb, dorsally, capsule with tubercles, suture line with knobs, annulus partially damaged, scale bar = 100 µm. Fig. 9: *Lophopus crystallinus*, site 2c, typical Fb, dorsally (right side), tripolar Fb, ventrally (left side), scale bar = 100 µm. Figs 10-13: *Lophopodella carteri*, Fb, site 2e. Fig. 10: Fb dorsally, spines recurved (artefact), scale bar = 100 µm. Fig. 11: detail of the annulus and its spines, air cells mostly intact, scale bar = 10 µm. Fig. 12: detail of the annulus and its spines, outer membrane of the air cells mostly destroyed, scale bar = 10 µm. Fig. 13: spines and hooks strongly magnified, one hook is anchor-like, scale bar = 10 µm (Fb = floatoblast).

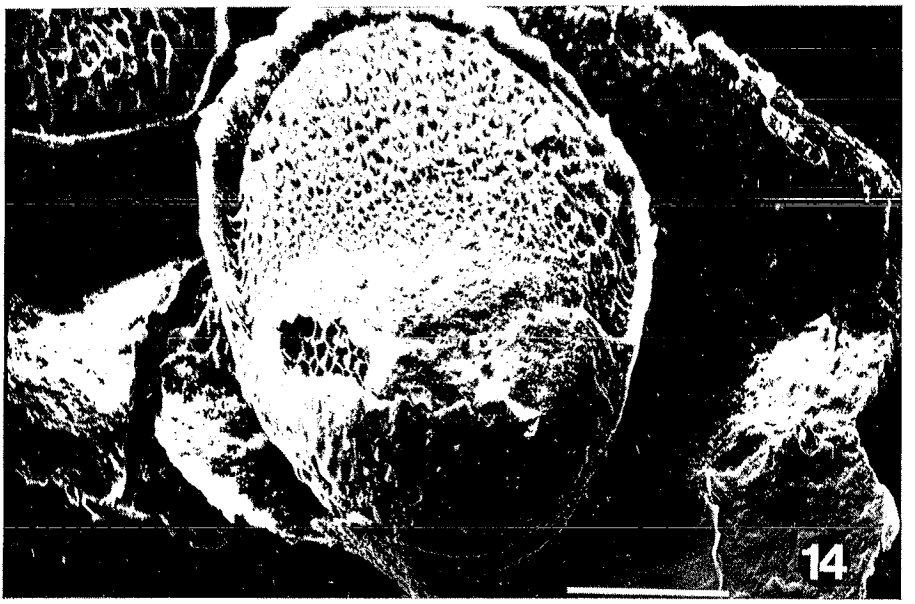


Fig. 14. - Abnormal statoblast of *Plumatella reticulata* showing the typical structure of a sessoblast in one half and features vaguely reminding of a floatoblast in the other half (scale bar = 100 µm).

The length of the floatoblasts varies from 372-428 µm (mean length: 403 µm); the width varies from 209-248 µm (mean width: 232 µm). The length/width ratio is 1,73. The length of the dorsal fenestra is about 119 µm and its width 109 µm; ventrally the corresponding measurements are 196 µm x 165 µm. Dorsally the annulus measures 134 µm in the polar part and 66 µm laterally; ventrally the corresponding values are 94 µm (polar annulus) and 29 µm (lateral annulus).

The SEM shows that the capsule is covered dorsally and ventrally with tubercles, which seem slightly more dense on the ventral side (figs 2-4). The two valves of the annulus are practically equally convex and the suture line forms an equatorial rib strongly resembling that of *Plumatella emarginata*.

Under the optical microscope the sessoblasts show the typical pattern of dark reticulated ridges described by Wood (1988, 1989). Observed under SEM the frontal valve of the sessoblast looks porous, this appearance being due to a fine net of irregular ridges covering the dorsal side of the sessoblast. It is even possible to distinguish major reticulation units comprising a variable number of minor «pores» (figs 5-6). The annulus lamella of the sessoblast is smooth on the upper side. The lateral wall of the sessoblast bears a more or less extended reticulation comparable to the netlike ridges of the frontal valve (fig. 7).

Our material contained one abnormal statoblast showing the typical structure of a sessoblast in one half and features vaguely reminding of a floatoblast (lacking the annulus, but showing a sort of suture ribbon) in the other half (fig. 14).

Hyalinella punctata (Hancock, 1850)
(Fig. 8)

One floatoblast was present in the material from site 2c.

Lophopus crystallinus (Pallas, 1768)
(Fig. 9)

The species was identified in material from site 2d (two fragments of colonies without floatoblast), site 2b (three colonies in the whole: two colonies with mature floatoblasts, and one colony with immature floatoblasts still restricted to their capsule) and site 2c (one colony fragment and 15 free floatoblasts, one of them with an aberrant tripolar form). Two single floatoblasts were collected in site 2e.

Lophopodella capensis (Sollas, 1908)

The material from site 1b corresponds to four colony fragments (one of them containing three floatoblasts and another containing one floatoblast) and 13 free floatoblasts (nine mature and intact; four immature with transparent annulus). One single floatoblast was present in the site 5 material.

Lophopodella carteri (Hyatt, 1866)
(Figs 10-13)

Numerous floatoblasts were collected in site 2e. Colonies were not found.

The floatoblasts are oval and are curved like a saddle. They are 900 -1100 µm long. The annulus is well encroaching on the capsule, so that the fenestra corresponds to approximately half of the capsule diameter. The annulus surface is reticulated; in some parts the outer membrane of the air cells has disappeared, so that the annulus surface looks porous. Both ends of the annulus bear spines with hooklets recurved downward; in our material the number of spines is relatively small, generally five to seven well developed specimens flanked by some others which are small and rudimentary (figs 11-12). The marginal hooklets of the spines are not numerous; normally they are simply recurved elements, but they may also be anchor-like (fig. 13).

Victorella pavida Saville Kent, 1870

The material from site 5 is constituted by fragments of colonies forming dense tufts around a calcareous Polychaete tube on which numerous hibernacula are fixed.

Discussion

Taxonomic notes

The Israeli *Plumatella reticulata* material basically matches the description given by Wood (1988, 1989). The floatoblasts are clearly larger than those of *P. javanica* Kraepelin, 1906 whose sessoblast, according to Lacourt (1968), is entirely covered by a reticulation (light microscope observation), whereas Wiebach (1967)

described a different structure, namely a regular tuberculation of the dorsal capsule of the sessoblast, a description somehow contradictory to the fig. 13 in one of his earlier papers (Wiebach, 1964) which shows an apparently reticulated surface. Let us point out that *P. javanica* occurs primarily in the Indian and Ethiopian regions (Lacourt, 1968). In bryozoan material from Lake Tanganyika which Wiebach (1965, 1970) identified as *Afrindella (= Plumatella) tanganyikae* (Rousselet, 1907) most of the sessoblasts had a characteristic reticulation on the front valve (under the light microscope). Wiebach (1970) considered this form as a mutation of the hitherto described smooth sessoblast. The formation of ridges on the frontal surface of *A. tanganyikae* sessoblasts was later on confirmed by SEM study (Wiebach, 1975). But it is obvious that the Israeli material does not correspond to this species which, by the way, had been considered by Lacourt (1968) as a dubious one. It is also evident that the material has nothing to do with *Internectella bulgarica* Grancarova, 1971 whose reticulated sessoblast has strikingly thick ridges (Wiebach, 1975) quite different from those of *Plumatella reticulata* as it was already emphasized by Wood (1988), not to mention the multiple other special features of *Internectella* (Grancarova, 1971).

As far as the above mentioned abnormal statoblast of *Plumatella reticulata* (fig. 14) is concerned, let's point out that Kraepelin (1887) speaking of *Plumatella* sp. asserted that he had observed all thinkable transitions between floatoblasts and sessoblasts (p. 108). Referring to our own observations we must say that it is the first time that we encountered a statoblast of this kind.

Floatoblasts of *Plumatella repens* and *P. fungosa* were identified under SEM according to the criteria developed by Massard & Geimer (1986, 1987).

Thanks to its very characteristic floatoblasts the determination of *Lophopodella carteri* does not generate any special problem. Our SEM photographs do not show any fundamental differences with those published by Bushnell & Rao (1979), Mundy (1980), Oda & Mukai (1985). The variability of the number and the disposition of the spines fit the results given by Oda (1955) and Toriumi (1956, 1962, 1963a,b,c, 1974). We only want to specify that Toriumi (1956, 1974) encountered in some *L. carteri* materials among normal convex spinoblasts a certain proportion of spinoblasts with straight or concave ends, the latter feature reminding of *L. capensis*. In our material these forms do not occur, so that no confusion with *L. capensis* is possible, especially as in *L. capensis* the concavity is not only constant but pronounced, and the spine number always limited to one unit (Lacourt, 1968; Massard & Geimer, 1991). Rao & al. (1985) state that most of the species of the genus *Lophopodella* described by systematics seem to be synonyms of *L. carteri*. As far as our own experience is concerned, we prefer dealing with *L. carteri* and *L. capensis* as two different species.

The correct determination of preserved *Victorella pavida* material is quite a problem because of its very strong resemblance to *Tanganella muelleri* (Kraepelin, 1887) (= *Victorella muelleri* Kraepelin, 1887). Macroscopically the colonies of the analysed material closely match the dense colony figured by Borg (1930, fig. 141). In our opinion we could distinguish in one autozooid a cardia divided into two equal sized portions by a median sphincter. If this observation is accurate the present material should be attributed to *V. pavida* and not to *Tanganella muelleri* where the cardia is not bipartite (Braem, 1951; Hayward, 1985). Nevertheless this determination remains somehow dubious and Jean-Loup d'Hondt (in litt.), whom we

consulted on this subject, warned us to be particularly circumspect when proposing a specific name for this material, granting however that statistically *V. pavida* is most likely. More details on the practical difficulties met in determining Victorellid material are given by Occhipinti Ambrogi & d'Hondt (1981).

Zoogeographical considerations

Plumatella reticulata was first described from Ohio (Wood, 1988, 1989) and it seems to have a wide distribution in North America (Wood, in litt.). The Israeli occurrence is the first record outside North America. It must be emphasized that this occurrence was anticipated by Wood (1988, 1989) who pointed out the striking resemblance between the floatoblasts of his material and the type 2 *P. emarginata* floatoblasts described from Lake Hula by Hastings (1938). In a previous paper this hypothesis could not be confirmed because the then analysed Lake Hula material did not yield any specimen liable to be related to *P. reticulata* (Massard & Geimer, 1991).

The occurrence of *Lophopodella carteri* in Israel is quite remarkable, the nearest hitherto recorded sites being 1500 - 2000 km away.

In the Oriental region this species is known from Iran (Nassarabad in Seistan), India, Burma, China, Korea, Formosa, Japan, Indonesia (Lacourt, 1968). Recent records from India are given by Rao & Kulshrestha (1962), Rao (1973, 1976), Rao et al. (1985). In the Ethiopian region the species is known from Kenya (de Beauchamp, 1936). Some authors (Kraepelin, 1914; Borg, 1936a,b; Lacourt, 1968) have stated that *L. carteri* reported from Ugogo in former German East-Africa (Kraepelin, 1891, 1893; Meissner, 1896; Rousselet, 1907; Loppens, 1908) and Central Africa (Ulmer, 1913) is doubtful and corresponds probably to *L. stuhlmanni*, a species that on the other hand is no longer considered as valid by Toriumi (1974) for whom it seems to be synonym of *L. carteri*. The distribution of *L. carteri* in North America is summed up by Lacourt (1968) and Wood (1989). Finally the species was described by Colledge (1917) as *Lophopus brisbanensis* from one site in Australia. On the European continent *L. carteri* was first recorded three decades ago in the Volga pre-delta (Abrikosov & Kosova, 1963); a second record was announced from the inferior part of the Rosica River and from pools along the Jantra River in Bulgaria (Grancarova, 1968). The latter occurrence is figured by Wiebach & d'Hondt (1978).

Wiebach & d'Hondt (1978) consider *L. carteri* as a cosmopolite. According to Lacourt (1968) *L. carteri* has a preponderantly Indian distribution with records from Ethiopian and Notogaean regions, in addition to which there is a probably artificial nearctic distribution. Concerning the latter assumption some doubts may be permitted; in fact although being rare in North America *L. carteri* has a relatively large distribution in this continent which in our opinion would rather plead for its being indigenous.

Bushnell (1973) assumes that the genus *Lophopodella* may have originated in the Ethiopian or possibly the Oriental region with *L. carteri* being either an earlier or more vagile species than the others. As far as the Israeli and the European occurrences of *L. carteri* are concerned it is worthwile noting that they are all localized on bird migration routes: Bulgaria and Israel on the route passing from eastern Europe over the Bosphorus and Asia Minor to Africa, and the Volga

occurrence on two different migration routes passing along the Caspian Sea, the first being the north-south route over the Arabian Peninsula to West Africa, the second the east-west route to the Indian subcontinent. Bird migration as a factor of Bryozoan distribution has been discussed previously in respect to the Israeli occurrence of *L. capensis* (Massard & Geimer, 1991). Wiebach & d'Hondt (1978) specify that *L. carteri* is particularly liable to be tranported by waterfowls. The settlement of *L. carteri* in the avandelta of the Volga is explained by Abrikosov & Kosova (1963) by floatoblasts imported by migratory birds.

Concerning *Plumatella casmiana, P. repens, P. fungosa, P. emarginata, Hyalinella punctata, Lophopus crystallinus* and *Lophopodella capensis* we refer to the list of Israeli Bryozoan records established by Massard & Geimer (1991) and the zoogeographical discussion related to that list. We only want to add that d'Hondt (1988) mentioned the occurrence of *Hyalinella punctata* near Tantura (collecting date: 2.7.1951) and the presence of *Fredericella sultana* in the Jordan River (pumping pipe, 7.2.1967), two records also referred to by Massard & Geimer (1991). We want to point out that *Fredericella sultana* is abundant along the shores of Lake Kinneret and that it is the dominant bryozoan of this lake. In this context it may be noted that Annandale (1922) comparing the Japanese Lake Biwa with Lake Tiberias (= Lake Kinneret) states that among the «Polyzoa» *Plumatella casmiana,* «not uncommon» in the Asian lake, is replaced in Lake Tiberias by *Fredericella sultana.* Considering the now well established occurrence of *Plumatella casmiana* in the Hula Nature Reserve, there is no valid reason to concur with Annandale's assumption of such a zoogeographical replacement of *Plumatella casmiana* by *Fredericella sultana.*

Lacourt (1968) pointed out that Zschokke (1900) made a mistake when stating that *Cristatella mucedo* had been found in Lake Tiberias by Barrois. This mistake was perpetuated by Marcus (1940) and Prenant & Bobin (1956). In fact as far as we know the holarctic species *Cristatella mucedo* has not yet been recorded in Israel although its presence is highly probable.

A Victorellid identified as *Victorella pavida* was recorded in Nahal Alexander prior to its death by pollution (Por, 1989). The present paper tends to confirm this record. Mediterranean records of *V. pavida* are relatively rare. Summing up the hitherto known records in this area Carrada & Sacchi (1964) noted some sites on the French mediterranean coast, in Italy (near Naples), in Greece (Aegean sea), in Bulgaria (coastal area of the Black Sea) and finally in an Egyptian salt lake near Fayum. Jebram (1976) ascertained the occurrence of *Tanganella muelleri* (= *Victorella muelleri*) near Naples (Annoscia, 1985). *Tanganella muelleri* and another Victorellid (*Bulbella abscondita* Braem, 1951) were described from the delta of the River Po in Italy (Jebram & Pisano, 1980). Occhipinti Ambrogi & d'Hondt (1981) confirmed the presence of *V. pavida* and *Tanganella muelleri* near Naples and established their occurrence in the North Adriatic. *Victorella pavida* was also recorded in Catalonian Spain (Zabala, 1986). *Tanganella muelleri* is present in Bulgaria (d'Hondt, in litt.).

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Postscriptum

The list of Bryozoa identified by Massard and Geimer from Lake Hula (including *Plumatella reticulata* and *Lophopodella carteri*) is enclosed in the following work published while the present paper was in press:

Ch. Dimentman, H.J. Bromley & F.D. Por, 1992. - Lake Hula. Reconstruction of the fauna and hydrobiology of a lost lake. - *Publs Israel Acad. Sci. Human*, Jerusalem, 170 p. (in English, summary in Hebrew).